A DIGITAL CORRELATION RECEIVER FOR THE GAURIBIDANUR DECAMETRE WAVE RADIO TELESCOPE

Ph.D. Thesis
by
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ABSTRACT

Presented in this thesis is the work on the design, development, construction and testing of an economical, digital multichannel correlation receiver for the decametre wave (34.5 MHz) radio-telescope located at Gauribidanur. The radio-telescope is a meridian transit instrument comprising a T-shaped array antenna consisting of a 1.38 Km long array along the East-West direction and a 0.45 Km long, 90-element array extending southward from the centre of the E-W array.

The receiver system consisting of the subsystems described below, has been designed, constructed and tested.

1. FRONT END OF THE DIGITAL RECEIVER SYSTEM

1.1 A/D Converter: Signals from the antenna are down converted to IF band, infinitely clipped and sampled to produce one-bit signals.

1.2 Delay Circuit: The one-bit signals are delay compensated in discrete steps for differences in the path lengths of the E-W and N-S signals. Additional delays are also added to compensate for positioning of the antenna beam in different declinations. Analysis of decorrelation resulting from the discrete delay setting for a given bandwidth is presented.

1.3 Correlator Circuit: The signal from the E-W array is correlated with that from each of the 90 elements of the N-S array to yield correlation coefficients corresponding to various spatial frequency components of the sky brightness distribution. Digital techniques to correlate double side-band signals directly without unfolding at IF band are discussed.

1.4 Integrator Circuit: The correlated one-bit signals are accumulated in a counter for different preintegration times required to study different types of sources.

1.5 Data Formating Circuit: The counter values of the correlated samples are converted to 2's complement values using a novel logic implementation whose analysis is presented. van Vleck corrections necessary for the one-bit signals are also applied.

2. FOURIER TRANSFORM (FT) PROCESSOR

The Sine and Cosine correlation coefficients are corrected for phase errors and are weighted by the desired grading function. The FT Processor hardware is based on the pipeline processing technique. The Fourier transformed signals can be further integrated, if required, over a prescribed postintegration period.

3. MICROCOMPUTER SYSTEM

3.1 On-line mode: The system is designed (a) to transfer the FT processor output to an incremental magnetic tape recorder using the Direct Memory Access mode, and/or (b) to display the brightness distribution map on a video monitor.

3.2 Off-line mode: The system is used (a) to store grading functions and the phase correction data in the appropriate RAMs and (b) to set the necessary control bits in the delay shift registers.

4. SYSTEM TESTING AND FIELD OBSERVATIONS

4.1 Laboratory Tests: Tests on the DSB correlator system and on the FT processor have been carried out and the results are presented. A discussion on the truncation and rounding-off errors is also given.

4.2 Field Observations: Field trials of the receiver have been carried out by observing some known radio sources and the results are discussed.

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